CHAPTER 6
Conclusions and Further Research

6.1 Conclusions

A vector control system for voltage sag compensator using back-to-back converters is proposed in this thesis. A proposed voltage sag compensator consists of 3 main parts as 1) voltage sag detection, 2) static transfer switch (STS), and 3) back-to-back converter. Each main part is analyzed and studied by using Matlab/Simulink simulation software.

In chapter 3, the voltage sag detections are discussed. By using the conventional voltage sag detection, the long detection time is achieved and the loads will be affected by this voltage sag. An improved voltage sag detection (IMSRRF-based voltage sag detection) is proposed in this thesis. By using IMSRRF-based voltage sag detection, the sag events are detected in a shorter time when comparing to the conventional method and this proposed method can be operated in the distorted grid voltages. The operation of the proposed voltage sag detection is also based on dq-transformation as the conventional method, in which the differentiator is an additional part. In this method, the phase of q-axis voltage is shifted by -90 degrees by a differentiator and then added to d-axis voltage to cancel the $2w$ component of d-axis voltage and finally compare to the DC reference to generate the voltage sag signal.

It can be seen from the simulation and experimental results that the proposed voltage sag detection gives better results when comparing to the conventional method.

In chapter 4, the STS is discussed. This is one important part since it is used to transfer the load when the voltage sag appears. When the voltage sag is recognized by voltage sag detection part, the next process (load transferring process) will be activated by the sag signal.

While its structure is very simple, its operation is complicate due to type of loads. In the case of resistive load and nonlinear load, the transfer process can be started and completed when the sag signal is valid. For the inductive load, however, the transfer process can only be started when the sag signal is true but it cannot be immediately completed due to the current of the inductive load. The transfer process will be completed when the load current reaches to zero and the transfer process is going to spend more times.

The last main part of the proposed voltage sag compensator is the back-to-back converter which is discussed in chapter 5. The back-to-back converter consists of supply-side converter (PWM rectifier) and load-side converter (inverter). While AC grid voltages are converted to the DC-link voltage by PWM rectifier, DC-link voltage is inverted to AC voltages (with fixed frequency and fixed voltage) by inverter. The load is fed the AC voltage from back-to-back via STS in case that voltage sag occurs. To get the good performance of DC-link voltage control, a vector control system is adopted to PWM rectifier and to get the simple structure of the back-to-back converter, the open loop scheme is applied to the inverter.

Three of preferred parts are combined as the proposed voltage sag compensator which is studied in chapter 5. The studies consist of simulation and experimentation. In this thesis, the Matlab/Simulink is used for simulation with various conditions. The

simulations are made up in the 2 types of voltage sag (0-pu single-phase voltage sag and 0.7-pu three-phase voltage sag) and 2 types of load (non linear load and inductive load). It can be noticed from the simulation results that the proposed voltage sag compensator can cope against the voltage sag in all conditions. The accuracy of these simulation results are verified through the experimentation and it can be seen that the operating simulation results are confirmed by experimentation results.

6.2 Suggestions for future work

- The tuning of the PI controllers may be further improved.
- The other control schemes such as feed forward and direct current controlled may be considered to improve the transient response of PWM rectifier.
- For the reason of robust AC output voltage of back-to-back converters, the closed loop control may be applied to the inverter.